



# Development of a 10μm optical storage cavity

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## Abstract

We have been developing a 10μm optical storage cavity for laser-Compton EUV source at Waseda University. The test stand has been launched in order to evaluate 10μm optical storage. Using 10W CO<sub>2</sub> laser and 2000 finesse cavity, it will be reached more than 1kW power inside the cavity. This situation can be useful for analyzing the thermal deformation of the optics. We will report recent progresses of 10μm optical storage cavity and future prospective in this conference.

## Motivation

### Laser-Compton Scattering

$$E_X = \frac{2\gamma^2 \cdot hc}{\lambda_L / (\cos\phi + 1/\beta)} \quad \text{Relativistic Electron}$$

High energy photon achievable with small  $\gamma$   
> Compact Accelerator

$$\theta = \frac{1}{\gamma} \sqrt{\frac{\lambda - \lambda_{\max}}{\lambda_{\max}}}$$

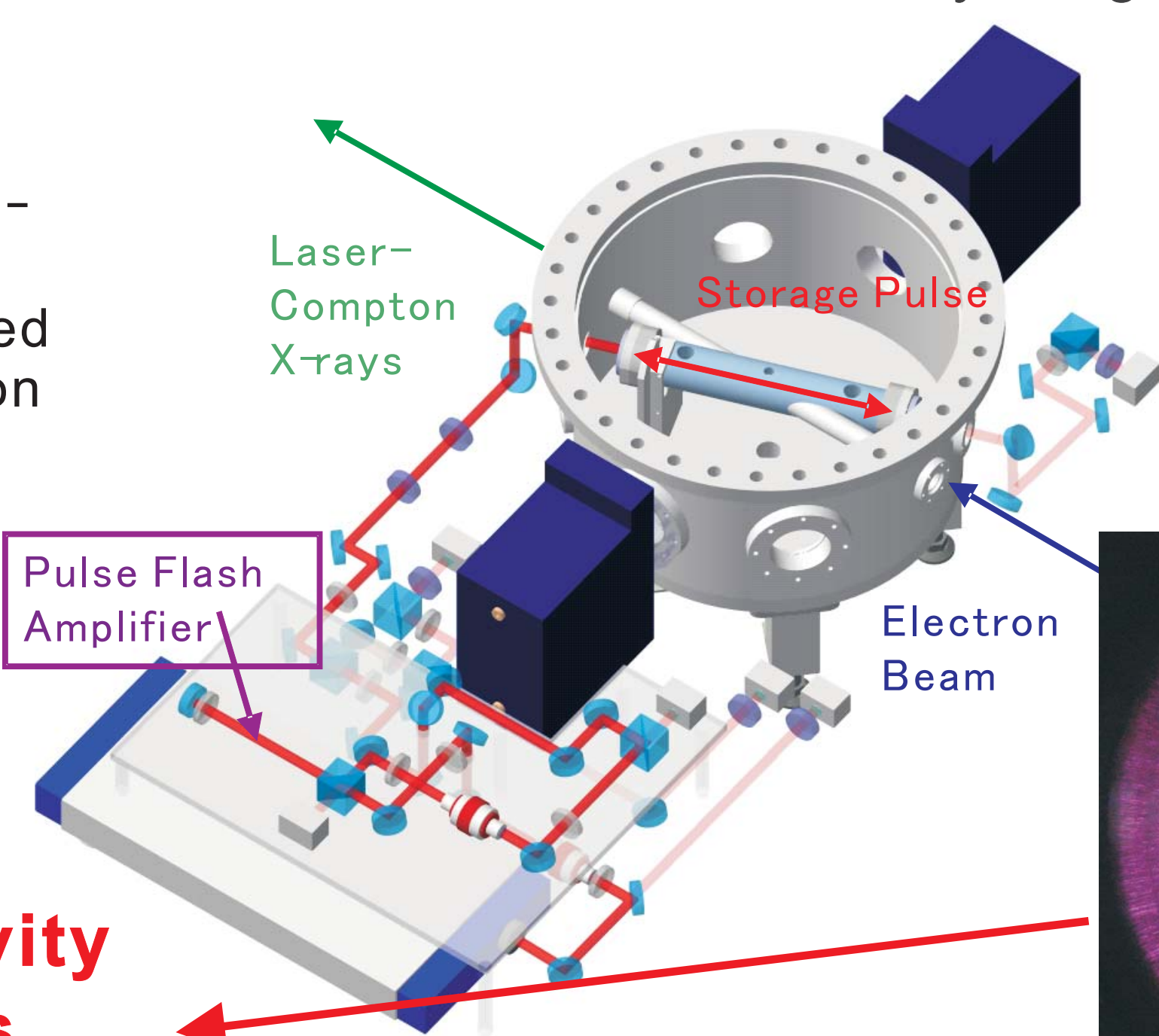
Large  $\gamma$  make good directive beam

$$N_X \propto N_e N_L (\lambda_L)$$

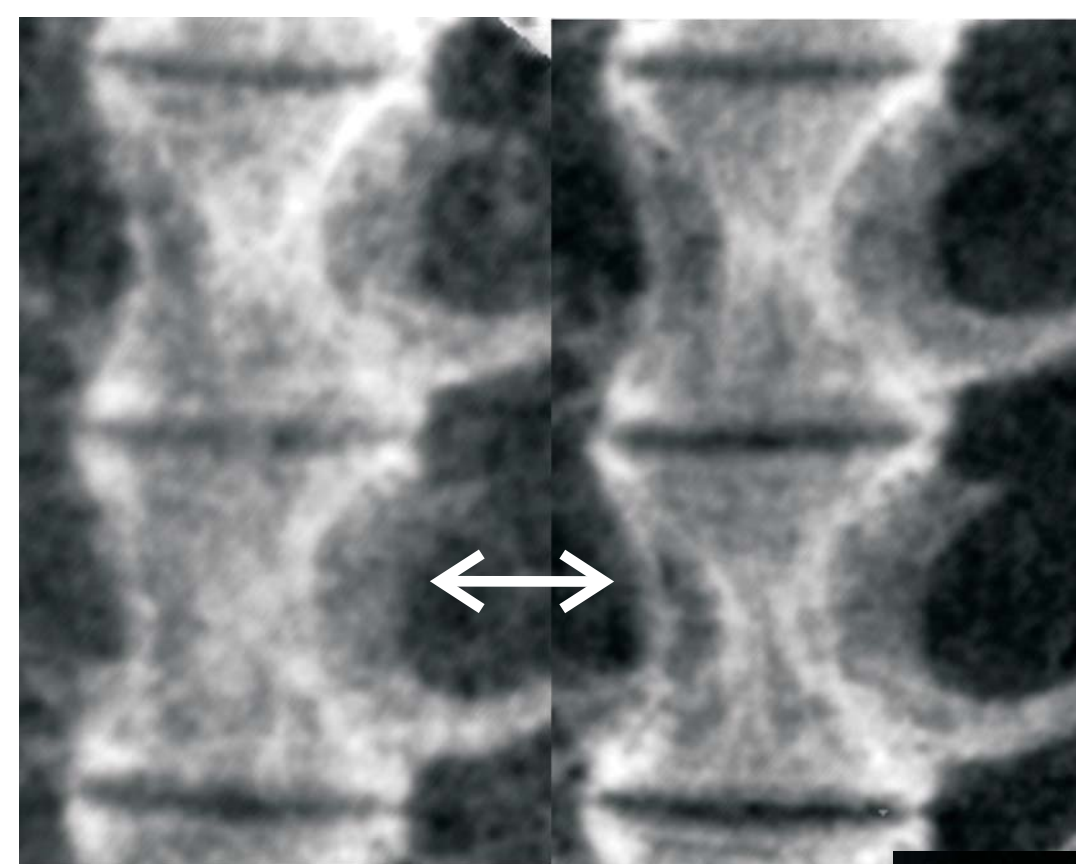
Photon flux proportional with Laser photon

CO<sub>2</sub> laser storage cavity has great advantages for LCS and we designed EUV source[2]

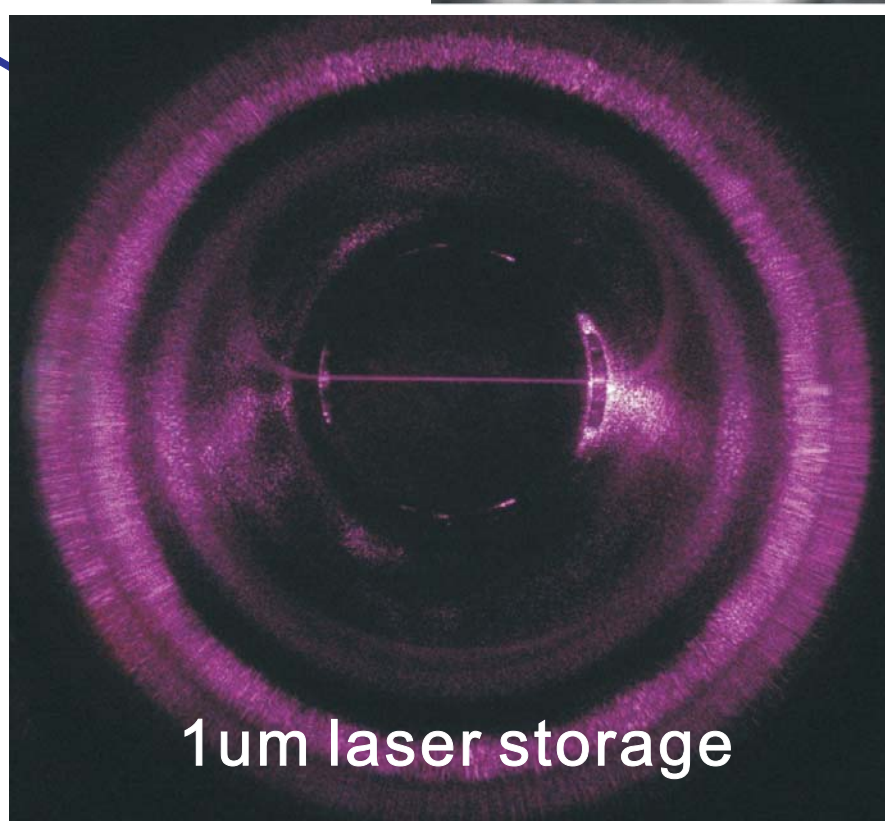
Our Optical Cavity based Laser-Compton Experimental Setup at KEK [1]  
> Demonstrate an X-ray image by LCS



Fish Bone X-ray Photo  
↓ With Refractive Contrast

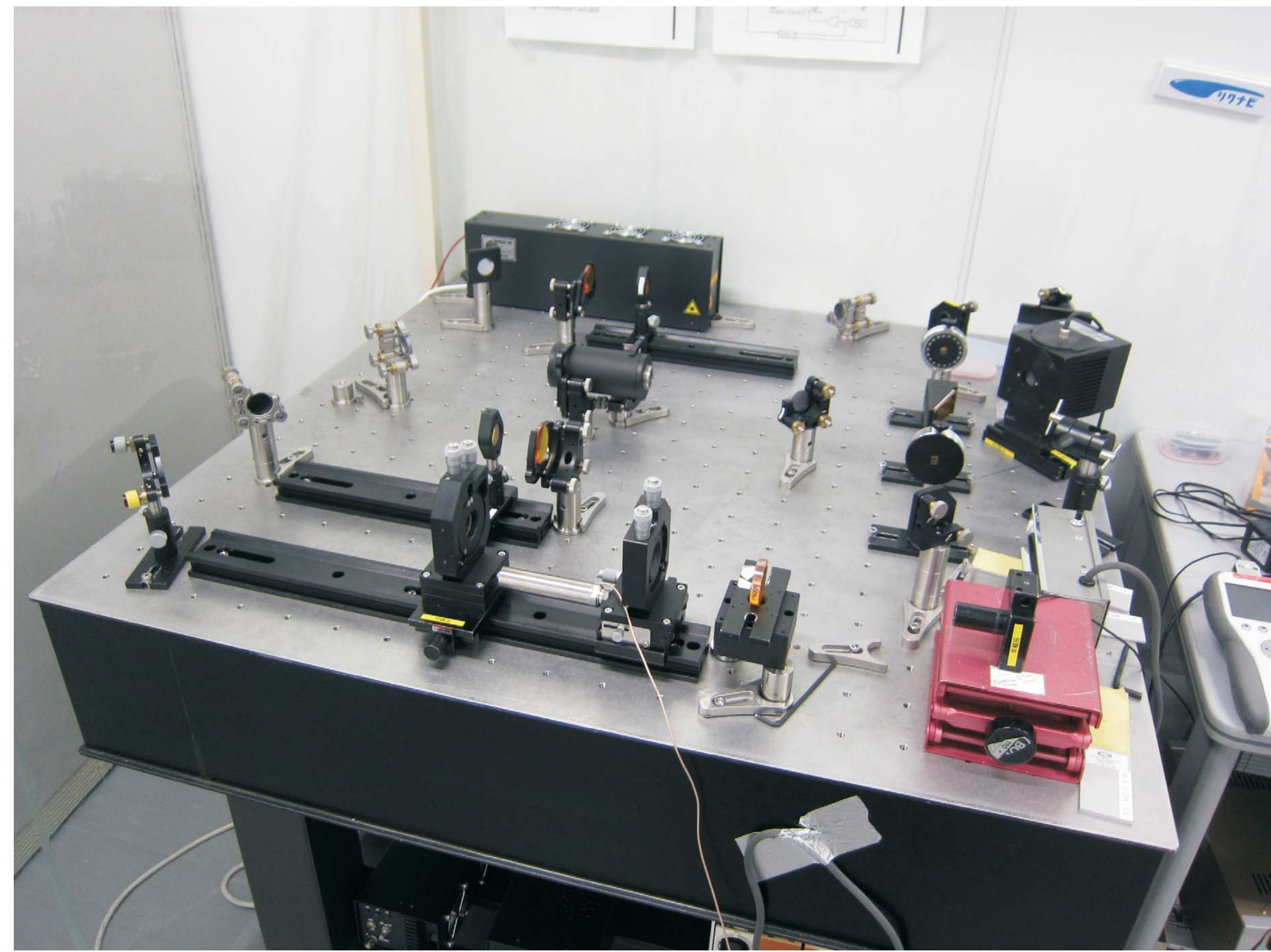


Refractive contrast achievement evaluate this LCS X-ray is "High Brightness"

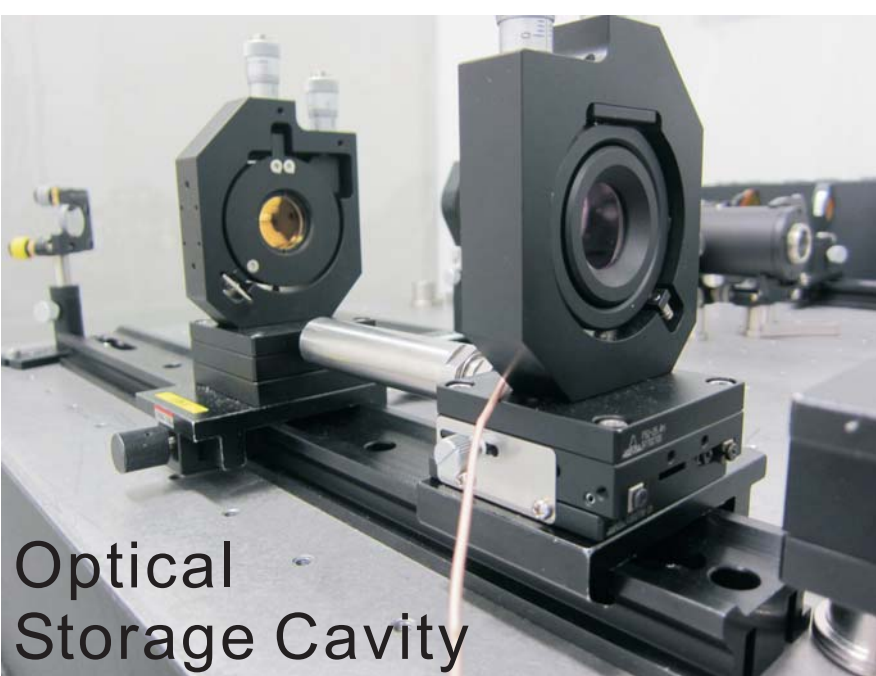
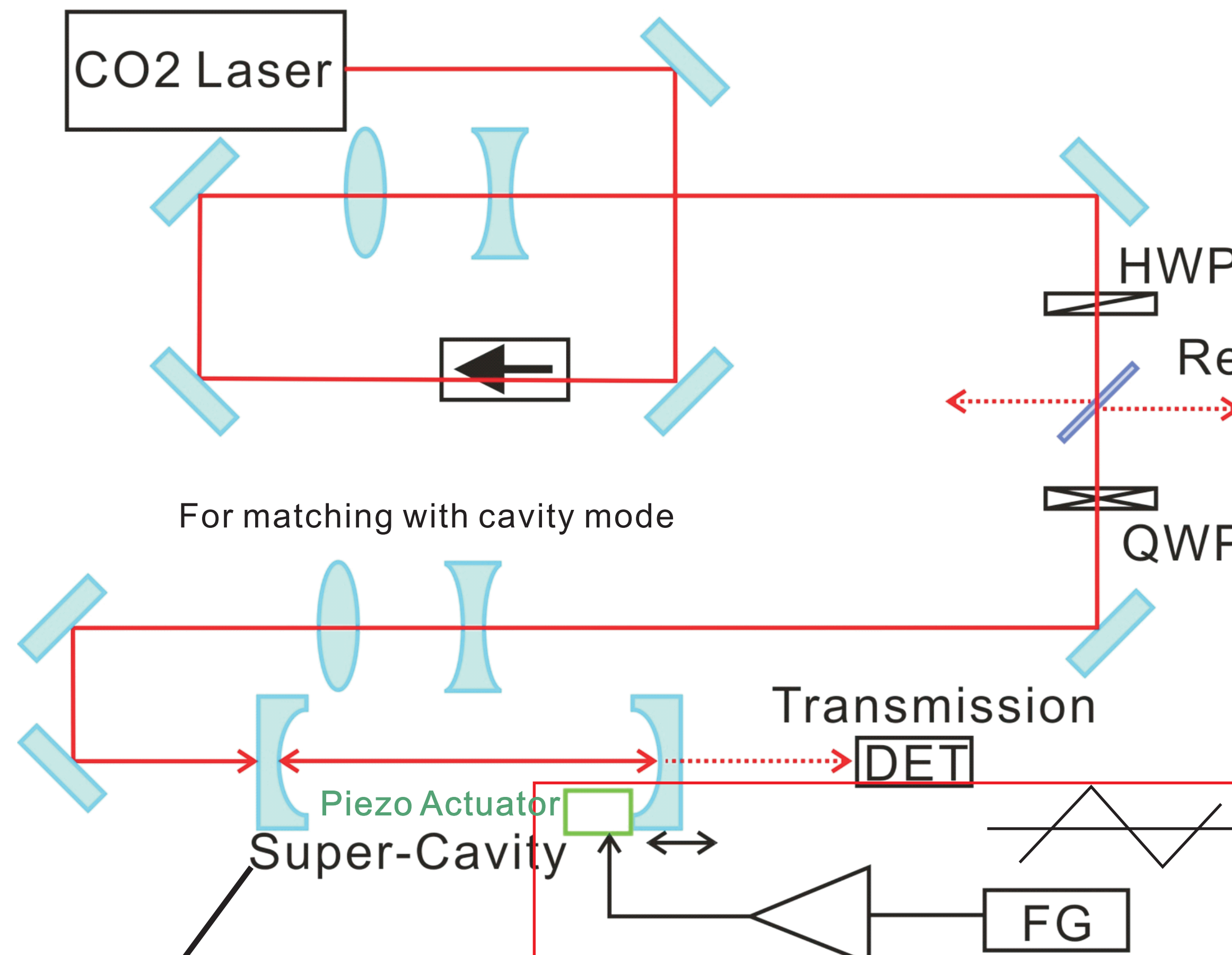


## CO<sub>2</sub> Cavity Experiments

Our CO<sub>2</sub> laser storage cavity test bench was launched

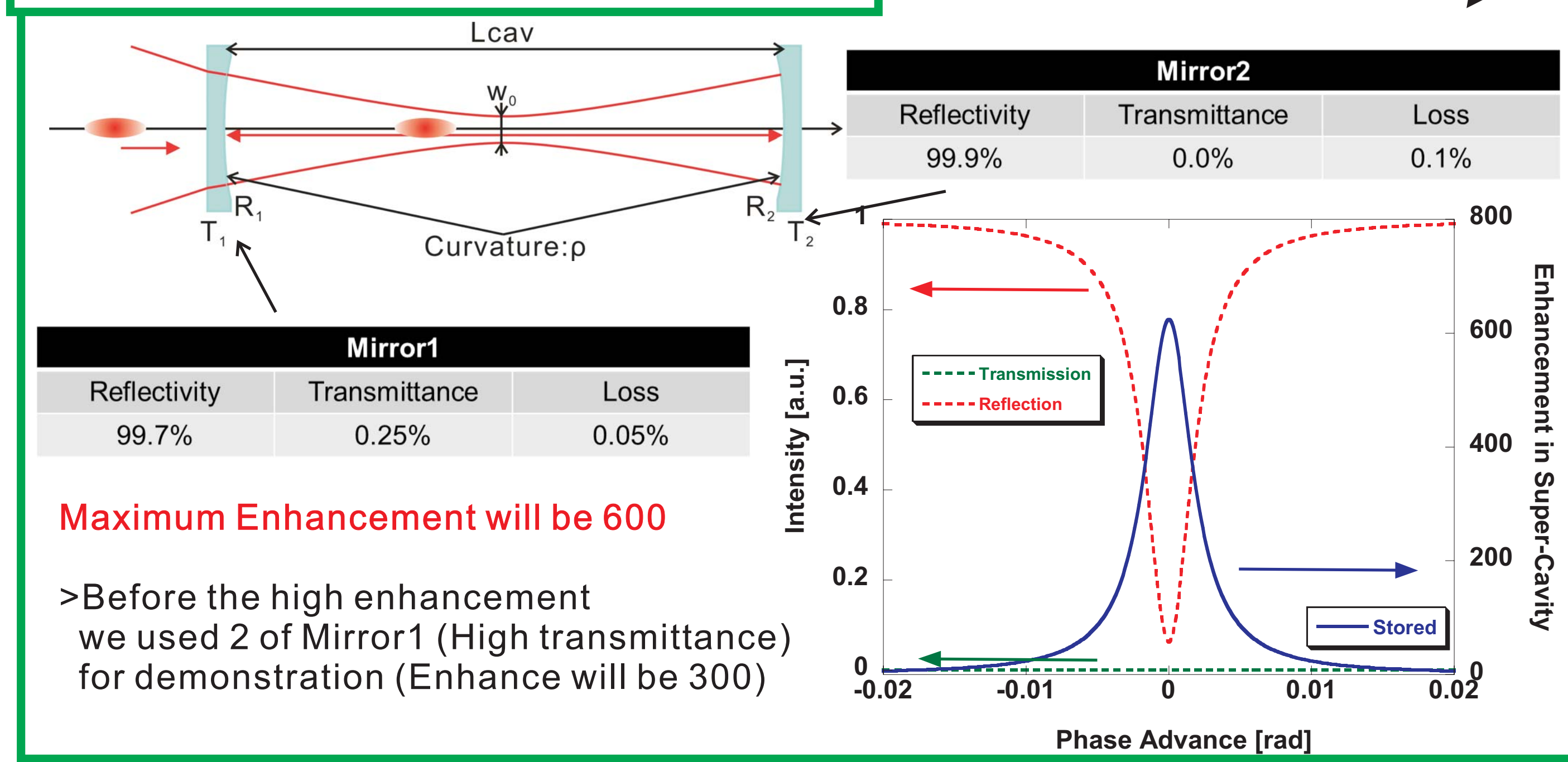


10W CW Single mode laser by JSC Plasma Inc.



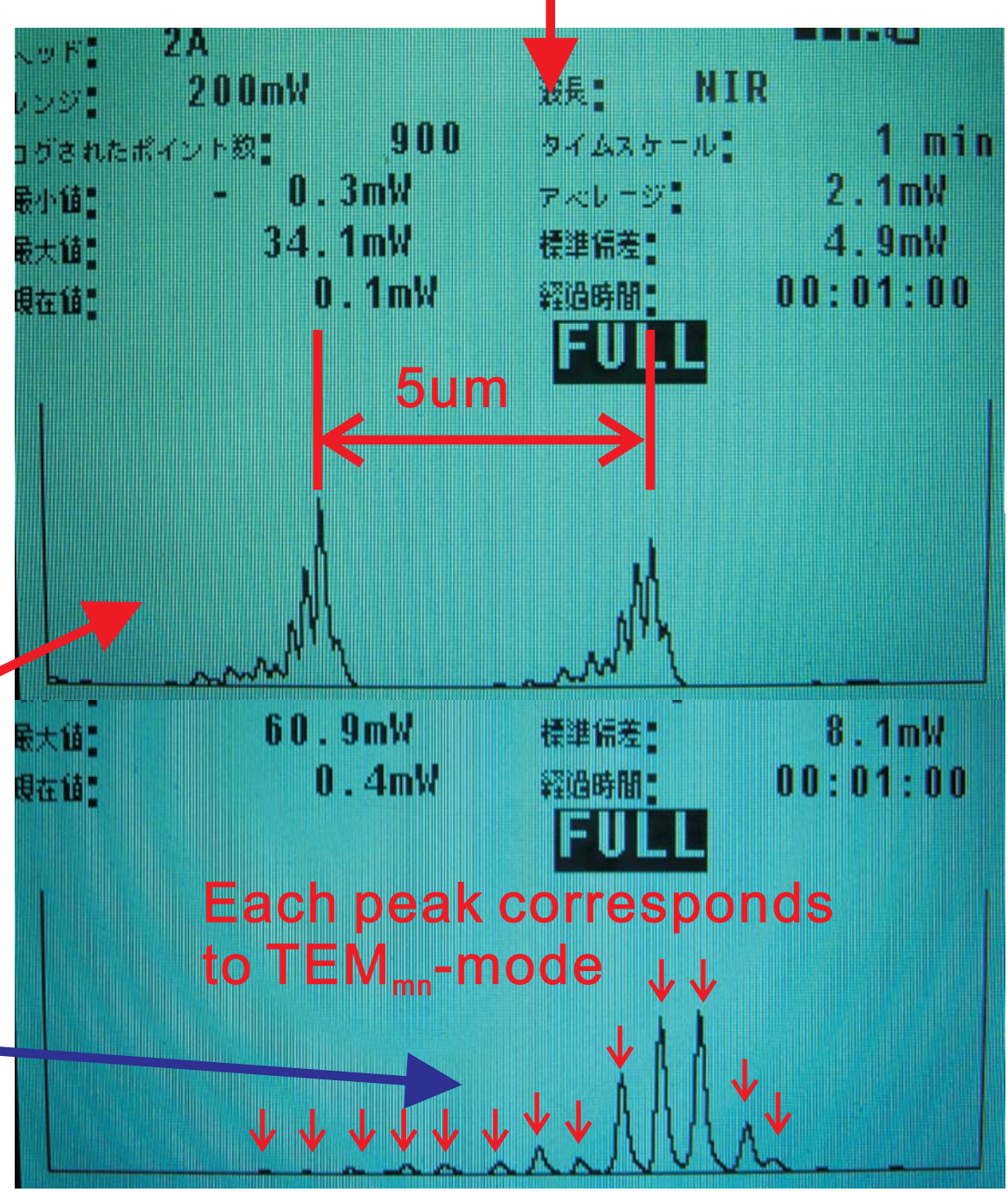
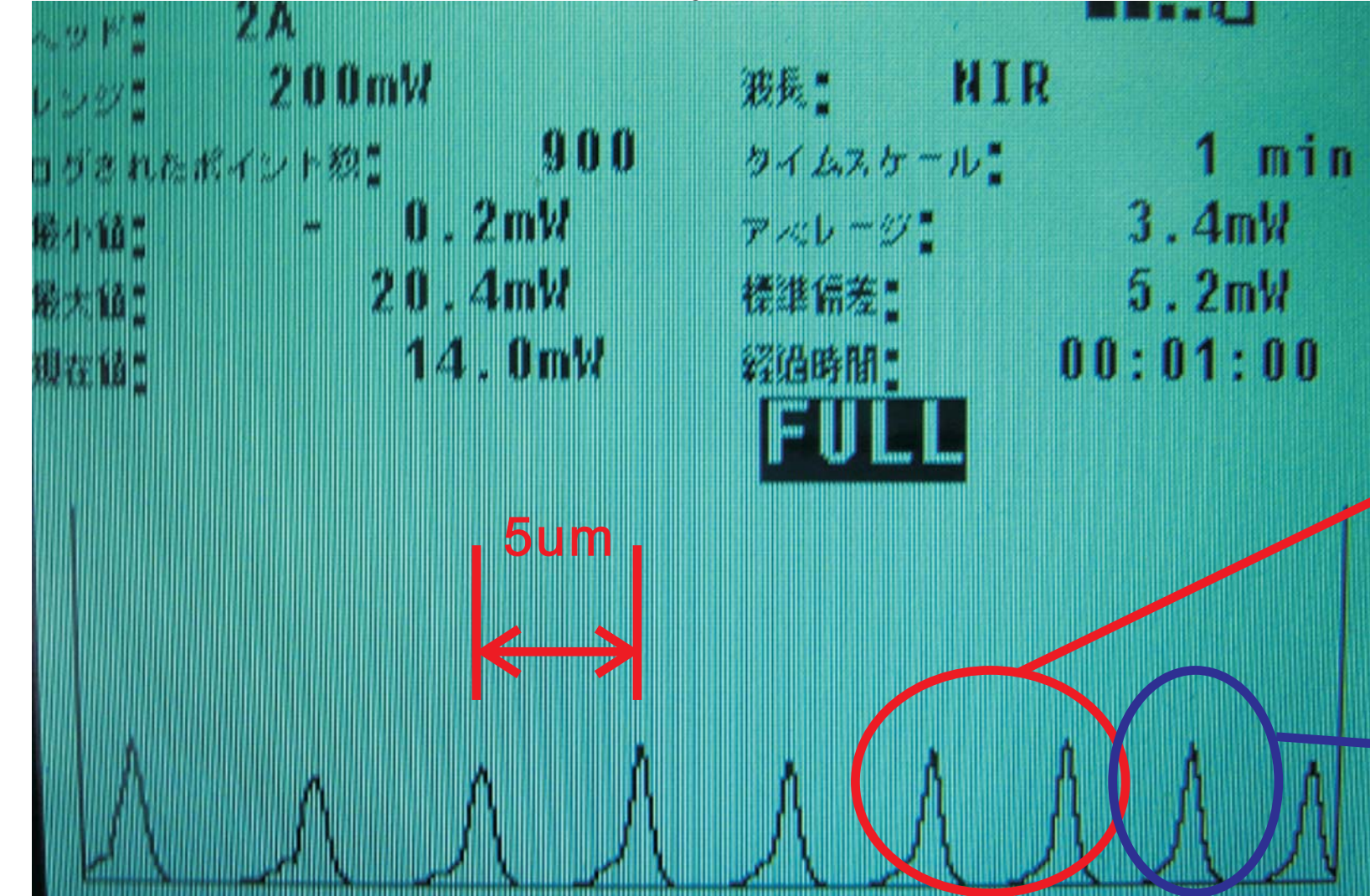
Scan Piezo actuator linearly, the modes matched with cavity length are stored and transmitted from the end mirror[3]

## Cavity Design at 10μm



## Demonstration of Cavity

We firstly observed a transmitted light from 10μm cavity  
Piezo was linearly scanned in all photo  
The power was detected by power meter



## Summary & Future Prospective

We started CO<sub>2</sub> laser storage cavity development.  
The test stand has already launched and will be updated soon.

The first cavity resonance was observed.  
> CO<sub>2</sub> laser cavity can be realized

After the photo-detector is delivered,  
we will try to single mode matching and store kW level CW laser

Our milestone of CO<sub>2</sub> laser development >>>  
We are planning to use cavity system to analyze the mirror deformation (Right of Table)

1 <sup>st</sup> step	CW storage demonstration	
2 <sup>nd</sup> step	High power test	Mirror damage test
3 <sup>rd</sup> step	Higher enhancement	Short pulsed CO2 laser development
	Need super-mirror development	Need short pulse demonstration Now considering QCL, DFG...

### CO<sub>2</sub> laser storage cavity application

Damage and deformation of CO<sub>2</sub> optics > key issue to increase the power

Direct analysis is required at more than kW class average power

> Storage cavity will be applicable for direct observation with Hartmann-Shack sensor[4]

Schematic of direct analysis >>

